maladies, avec beaucoup de ſuccés. C'eſt aux medecins à en conſtater les bons effets par l'uſage, et en obſervant les differens etats ou degré de l'eau quand ils l'employeront.

Il ſe préſente une difficulté dans l'uſage; c'eſt ſon changement ſubit: cependant dans cet etat plus foible elle préſente les mêmes vertus, mais à un degré peut-être inferieur. Il ſeroit poſſible, dans le tems où elle eſt forte, de la conſerver en bouteille, comme on fait celles de *Spaw* et *Pyrmont*, en y donnant les mêmes attentions.

Si mes occupations et le tems que je paſſerai ici avant d'aller en Europe, me permettent d'analyſer l'eau des autres puits dont j'ai parlé, elles donneront peut-être les mêmes reſultats ſans avoir le même inconvenient.

ed in Europe, in many diſeaſes. It is the province of the phyſician, to demonſtrate their good effects by trial, and by obſerving the different ſtates, and degrees, in which they may be drank. If directing the uſe of this water is attended with any difficulty, it muſt ariſe from the ſudden changes to which it is liable; but in the ſtate of its weakeſt impregnation, it ſeems to poſſeſs the ſame qualities, though perhaps in an inferiour degree. In its higheſt impregnation, it might be preſerved in bottles as the waters of Spa and Pyrmont are, if the ſame attention was employed.

If my engagements, and the time I have to ſpend before I embark for Europe, ſhould permit me to examine the other ſprings mentioned, perhaps they might afford us the ſame agreeable qualities, without the concomitant inconveniences.

XXVI. *On the Theory of Vegetation.* *By* NOAH WEBSTER, JUN. ESQ.

Hartford, June 12th, 1790.

SIR,

THE theory of vegetation is a ſubject in itſelf curious and amuſing to a philoſophic mind, and has always been

been conſidered in this light by rational enquirers after truth. But I queſtion whether the true principles of vegetation may not furniſh more uſeful and important leſſons to our farmers than even philoſophers generally imagin.

It is a well known fact that many vegetables, as clover, peas, beans, and vetches, help to fertilize exhauſted feelds, eſpecially if *plowed in*, as the farmers call it. But I cannot find that the true reaſon of this effect is generally underſtood. I wiſh if poſſible to diffuſe a knowledge of the cauſe, in full confidence that the principle may be applied to many beneficial purpoſes in agriculture.

Vegetables, when analized, are found to conſiſt of water, earth, oil and ſalts. It ſeems to be the generally received opinion among philoſophers, that the cementing principle, by which the component parts of vegetables are held together, is fixed air. With theſe ſubſtances there is united a portion of phlogiſton; but the parts which contribute moſt to fertility are oil and ſalts. Now it is agreed among the lerned, that vegetables are furniſhed with inhaling or abſorbing pores, and that the pores of the leaves and branches ſerve the double purpoſe of alternately inhaling and exhaling, according to the temperature of the atmoſphere. All this is admitted by modern philoſophers, yet they contend that vegetables derive their principal nurriſhment from the earth. It appears to me this cannot be true in the extent it is commonly ſuppoſed; for if true, I do not ſee how vegetables of any kind ſhould enrich the land on which they grow, ſo rapidly as ſome of them do.

A crop

A crop of clover will fertilize an exhauſted feeld, altho the clover is mowed, and the body of it carried from the feeld. But if the clover draws the principal part of its oil and ſalts from the earth, and the moſt of the growth is cut and carried off from the feeld, one would think that inſted of enriching, it would impoveriſh the ſoil.

The conſtituent parts of vegetables are contained in the atmoſphere; and it is rational to ſuppoſe that different vegetables imbibe more or leſs nurriſhment from the air, according to their different organization. Thoſe plants which are of a firm texture probably imbibe moſt of their nurriſhment from the earth; as flax and hemp, which require very rich land and impoveriſh the ſoil where they grow. But plants which are of a more ſpongy texture, and whoſe leaves have larger pores, probably imbibe moſt of their food from the atmoſphere; as clover, vetches, peas and many other ſucculent plants. This I take to be the reaſon why the latter enrich the ſoil where they grow; eſpecially when ſuffered to rot upon the ſoil. They imbibe the oily and ſaline ſubſtances from the air, and their veſſels ſerve as tubes to convey them to the earth.

It may be ſaid, that the particles inhaled by the leaves, during one part of the day, are thrown off by perſpiration, during another part. But it is only the moſt volatile and fluid part of the nurriſhment which is thrown off in this manner, that is, the water. The exhalations of plants are moſtly during the heet of the day; the proceſs of abſorption is principally during the night, and then is the time

when

when vegetables grow moſt rapidly. This is a fact within every man's obſervation. The more ſolid parts of vegetables therefore, when imbibed, immediately cohere and attach themſelves to the plant, and the watery particles only or principally are liable to be exhaled by common ſummer heet. It appears probable that the nurriſhment of the more ſucculent plants, being moſtly imbibed from the air, conveys more of the enriching ſubſtances to the roots, than is derived from the roots to the branches. And this may be the reaſon why a growth of clover will fertilize land, even when the body of the crop is carried off.

But whether this is true or not, it is a fact that vegetables do imbibe nutriment from the atmoſphere, and this is undoubtedly the reaſon, why all vegetation will fertilize land, provided the whole growth is permitted to ferment and putrify upon the land. It is owing to this circumſtance merely that land newly cleered is rich and fertile. The trees have for ages been inhaling the oil and ſalts of the atmoſphere; the leaves and ſome of the limbs have been annually falling upon the earth, where they putrify and form a rich black mold, abounding with oil and ſalts, which were collected from the air. And I am ſurprized that our farmers, who are conſtant obſervers of theſe facts, have not attended more to the principles which produce them; for I do not ſee how men, who are conſtant eye-witneſſes of the effect of putrified vegetables in fertilizing land, can ſuffer their old feelds to lie barren for a number of yeers in order to become rich. The ſeed of clover, beans, peas,

buck

buck wheat, rye, turnips, oats and almoſt any other plant the ſeed of which can be collected, would be purchaſeable at a ſmall expenſe, and a crop or two turned into the moſt exhauſted ſoil, would render it fertile. Suppoſe a man ſhould ſow three buſhels of oats upon an acre, (and on poor land a large quantity of ſeed would be neceſſary) the expenſe would be 4*ſ.* and 6*d.* Add to this, a day's plowing in preparing the ground, and another, in plowing in the crop, when neerly full grown. The expenſe and labor are not conſiderable, and ſuch a quantity of freſh vegetation, covered with earth, and there fermenting, would be equal to twenty, thirty or perhaps fifty loads of ſtable manure. The neceſſity of attending to theſe principles is increeſing every day in this part of America, where a great part of the land is impoveriſhed by long cultivation. To ſuffer old feelds to lie without any vegetation upon them, except a ſpontaneous growth of weeds, is an immenſe loſs to the farmer. The air contains the principles of fertility, but a barren earth will attract and abſorb theſe principles very ſlowly, without the help of vegetation. The plowing of land has a good effect, eſpecially juſt before winter, as by looſening the ſurface, it prepares the ſoil for receiving and retaining the ſalts with which the atmoſphere is impregnated. But the moſt efficacious method of collecting the fertilizing particles of the air, is, to ſeed the earth with ſome of the ſucculent plants, which feed upon theſe particles.

It ſhould be obſerved further that when the plants have obtained their growth, they ſhould be plowed in; for being covered, they produce fermentation, and the oil and ſalts are

all

all blended with the earth; whereas when ſuffered to putrify upon the ſurface of the ground, they dry up, and their fertilizing ſubſtances are again mixed with the atmoſphere. This remark, if true, expoſes the abſurdity of the practice of feeding cattle during winter, in the open feeld. In Rhode-Iſland the farmers have few barns; the hay being ſtacked and their cattle fed upon the mowing feelds. But the manure they leave upon the land is much leſs than the ſame cattle would make in a ſtable, or at leaſt is leſs uſeful, from the manner in which it is caſt upon the land. Beſides vaſt quantities of hay are waſted, and being thrown upon the ground in a ſcattered manner, it produces no fermentation and little benefit to the ſoil. In addition to this, cattle expoſed to the ſevere cold of winter, eat more hay, and do not grow to the ſame ſize, as cattle kept in a warm ſtable.

I have one remark more to make, which derives its force and propriety from the doctrin, that vegetables receive much of their nutriment from the atmoſphere. It is, that in ſevere drouths the leaves of garden plants ſhould be watered as well as the roots. We often heer gardeners ſay, that certain plants will die in a drouth, altho watered every day. Indeed it cannot be otherwiſe, when the largeſt part of the plant is almoſt deſtitute of nurriſhment. The roots of many plants will bear to be robbed of nurriſhment much better than the leaves; thus a cucumber will live longer by watering the leaves than the roots. Copious dews will partially ſupply this pabulum for the leaves, and this perhaps is the meening of that paſſage of ſcripture which ſays, "a miſt

miſt went up and watered the face of the earth;" as the caſe is ſtill in ſome eaſtern countries.

I will cloſe this letter, Sir, by relating an experiment I have lately made to aſcertain the evaporation or perſpiration of plants, growing in a damp cellar, unconnected with earth.

On the 9th of May I weighed two potatoes, on which the young ſhoots juſt began to appear. I placed them both in a dark corner of the cellar, on a dry piece of timber. I weighed them both on the 28th of the ſame munth, and on the 11th of June. The reſult of the whole follows:

The largeſt weighed.

	oz.	pwt.	grs.		pwt.	grs.
May 9th,	1	18	19			
May 28	1	13	0	—loſs of weight in 19 days	5	19
June 11	1	12	11	—loſs of do. in 14 days	0	13

The ſmalleſt weighed.

	oz.	pwt.	grs.		grs.
May 9th,	1	0	8		
May 28	0	19	19	—loſs of weight in 19 days	13
June 11	0	19	4	—loſs of do. in 14 days	15

The ſhoots in the meen time had grown to the length of two and three inches. Thoſe of the largeſt, when broken off, weighed 1 penny weight 7 grains; thoſe of the ſmalleſt, 18 grains; ſo the actual diminution of the potatoes in 33 days, was 6 penny weight 8 grains of the largeſt, and 28 grains of the ſmalleſt.

The perſpiration of plants is aſcribed to the expanſion of the air in the tracheæ, in conſequence of being heeted. The abſorption

abſorption of moiſture is owing to the contraction of the air in the ſame veſſels, which occaſions the exterior veſſels to dilate. Now a potatoe kept in a cool cellar of uniform temperature cannot perſpire very freely; and probably the ſimilar roots, placed in water and expoſed to changes of heet and cold in the open air would have thrown off by perſpiration, twenty times the quantity of water, which thoſe did in the cellar. At the ſame time, a vegetable confined to a dark room will flouriſh but indifferently, as it is deprived of an eſſential part of its food, phlogiſton.

Whether this communication contains any thing new or ſufficiently intereſting to deſerve the notice of the American Academy of Arts and Sciences, is left wholly for you to determin. All I know for certainty is that it proceeds from a ſincere deſire to ſerve the agricultural intereſt of my country, and that I am, Sir, with great reſpect,

your obedient and
very humble ſervant
NOAH WEBSTER, JUN.

Rev. Dr. WILLARD.